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ABSTRACT

High definition television (HDTV) is an innovation in television that promises improvement in the image the television receiver displays. There are major differences between HDTV and the current National Television Standards Committee (NTSC) formats, and these technological changes are at the heart of debates over the introduction of HDTV. The process of selecting a HDTV standard is exacting and complicated, but no government sponsored standard can be developed without the input of a television industry that is in economic straits largely because of foreign competition. The history of debate over HDTV implementation is traced. The industrial policy issue is a real concern in the United States. No matter which standard is adopted in the United States or Europe, the Japanese will doubtless continue to compete. The HDTV situation is perhaps the first time in the history of broadcasting that the Federal Communications Commission appears to be forcing a technology on broadcasters. The first step is the adoption of a transmission standard in 1993. The second step, formulating a technology policy, will be more difficult. Appendix A presents a proposed testing schedule, and Appendix B describes proposed HDTV systems. (Contains 113 references.) (SLD)

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HDTV: In Search of a Policy

by

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In this country, HDTV is a term that has been applied to various advances made in television since its debut at the New York World's Fair in 1939. In simple terms, most people would define HDTV as a system providing a vast improvement in the image the television receiver displays. In other words, it is one more technological step in the evolution of television, just as the current National Television Standards Committee (NTSC) color image or the addition of stereo sound were major advances when they were introduced. Some argue that HDTV means an incompatible system that requires a new receiver, transmitter, and more spectrum.[1] One called it an "hallucinogen."[2]

There are four major differences between the proposed HDTV formats and the NTSC format: (1) With NTSC there are 525 scan lines while HDTV would provide from 1050 to over 1125; (2) in HDTV the bandwidth for the color signals would be increased; (3) the NTSC aspect ratio of three-units high by four-units wide could increase to 16:9; and (4) HDTV would provide digital high-fidelity sound.[3]

There is more to the HDTV discussion than finding a high-resolution image for "couch potatoes."[4] Richard Wiley, chairman of the FCC Advisory Committee on Advanced Television Service, stated, "What's at stake here is the future of television service in this country and the United States' role in high technology."[5] Further, when HDTV is connected to High-Resolution Systems (HRS) technologies, which include computers and communications sectors, a synergy is created that is only limited by the imagination,[6] not to mention the possibility of spin-off technologies that may be created. These proposed HDTV industries and their related industries are the focus of government interest.

Does technology drive government policy or does government policy drive technology? This is often a question that surfaces when a new technology is in its infancy. The United States Government began to take a serious interest in High-Definition Television (HDTV) in 1987.[7] Perhaps because of the government's action, HDTV has become one of the more discussed technologies in the continuing debate over whether the United States should have an established industrial policy similar to Japan and Europe. This paper will focus on the role of the government in the development of HDTV in the United States. The research question to be answered is did government policy drive the technological development of HDTV in the U.S.?

The 18th century French historian Alexis De Tocqueville noted two major character traits of the American people: first, they love to be led and second, they treasure their freedom.[8] The development of HDTV technology and policy illustrates De Tocqueville's observation. On one hand, the industry wants to be independent of the government; on the other hand, it wants assurances of protection by the government.

In the early 1960s, American researchers had the necessary pieces to develop an HDTV system but it was not pursued.[9] There was some question as to whether the market was sufficient to warrant pouring money into research to implement the system. A typical response from manufacturers was that there was no practical application.[10]

A second stumbling block for early United States development was concern over the role government would play. Television manufacturers had already been burned by government policy in the case of black and white television technology.[11] Because of the government's slow reaction in that

case, the Japanese were able to sell TV sets to Americans at a lower cost than that of domestic manufacturers.[12]

The consumer electronics market has been characterized as "fierce competition, large volume production, and low profit margins."[13] A brief overview of the development of HDTV shows an American industry that is very cautious and financially strapped because of foreign competition. Yet, a government sponsored standard for HDTV cannot be developed without the input of industry. Richard Wiley said, "The theory is that you've got all these private interests; they're all competing against one another, and that out of all the welter of private interests, all operating in a public mode, is likely to come a fair evaluation."[14] It is the role of the government in this situation to ensure a level playing field.

The process of selecting an HDTV standard is an arduous task. It has to be considered from at least three different perspectives or standards: a production standard, a transmission standard and a reception standard.[15] The three standards have to be compatible for the system to work and each standard has unique problems.

In 1985, the United States was ready to adopt the Japanese MUSE system as a production standard. This system had 1125 scan lines at 60 cycles and is often referred to as 1125/60. Japan's National Broadcasting Company (NHK) lead research efforts in HDTV since 1965 by spending over $150 million on the project.[16] NHK had issued contracts to companies such as Toshiba, Matsushita, Mitsubishi, Sony and Hitachi that develop their own equipment under the guidance of NHK. These companies have spent from $700 million to as much as $1.3 billion on HDTV research.[17]

Internationally, NHK promoted the MUSE system as a standard.

By 1984, the Japanese had developed its fully functional MUSE HDTV system. At the international standards meeting of the International Radio Consultative Committee (CCIR) in Dubrovnik, Yugoslavia, in 1985 the Japanese proposed their MUSE system as an international production standard. SMPTE, which had been investigating HDTV since 1977, and the Advanced Television Systems Committee[18] recommended that the State Department adopt the Japanese 1125/60 standard as a production standard. The Japanese proposal was defeated by the Europeans.[19] The United States withdrew its support of the 1125/60 production standard at the 1989 CCIR meeting because of mounting pressure from the electronics industry and government.[20] Domestically, however, there has been little government or private action taken on a production standard. Television commercials and programs in this country that have been produced in an HDTV format use the 1125/60 system.[21]

In the area of transmission, private companies such as RCA and CBS began testing and developing systems in the late 1970s and early 1980s. RCA's Sarnoff Labs began experimenting with HDTV in 1977 eventually spending $40 million on initial research.[22] In 1982, CBS conducted direct broadcast satellite (DBS) HDTV research. It developed a system that would use two television channels for a DBS HDTV transmission.[23]

Through all this, research into a reception standard was dormant. Beginning in the 1970s and continuing through the early 1980s, domestic competition in television receiver manufacturing was stiff. Television manufacturers were primarily beaten by Japanese imports. Finally, Zenith remained as the only United States owned television manufacturer.[24] Robert Hansen, head of consumer products at Zenith Electronics Corporation, responded to questions of HDTV development saying, "We won't work on

anything we don't see a market for."[25] It was the fierce competition and low profit margin that kept most United States industries from entering the playing field. Why should they? Perhaps it was this question that prompted the United States government to encourage a reticent industry.

In 1986, the Commerce Department and the FCC began studying ATV technologies (ATV includes HDTV and was the term used by the government before HDTV).[26] The National Telecommunication and Information Administration (NTIA) of the Department of Commerce commissioned Darby Associates to explore the potential market and examine public policy implications of ATV. The "Darby Report," entitled *Economic Potential of Advanced Television Products*, was released in April 1988. It reviewed the development of consumer electronics and estimated that the economic potential of ATV markets in this country alone could range anywhere from $1.7 billion to $144 billion per year, depending on economic conditions.[27]

In December 1988, the NTIA issued a *Notice of Inquiry* (*NOI*) for a production standard.[28] It used the Japanese concept of HDTV to expand its concept of ATV to something other than just receivers (see Illustration 1).

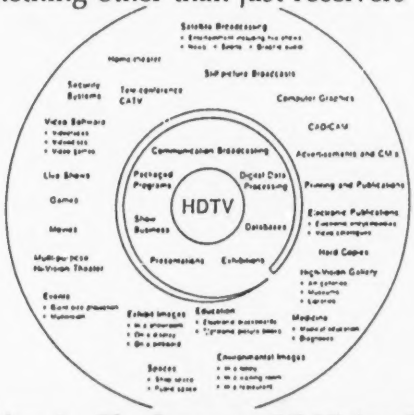

Illustration 1 - The Japanese Hi-Vision System -

High Definition Television, Hearing before the House of Representatives Comm. on Science, Space, and Technology, 101st Cong., 1st Sess. 12 (1989) at p. 60 (statement of Alfred C. Sikes, Assistant Secretary for Communications and Information, NTIA, Dept. of Commerce).

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The NTIA noted that ATV has a potential impact on the United States semiconductor industry, the computer industry, implications for national security, and implications for international trade.[29]

Alfred Sikes, Assistant Secretary for Communications and Information for the NTIA, distributed the "Darby Report" to members of the electronics industry. The American Electronics Association (AEA), which is comprised of 3,500 companies and 45 United States engineering universities, studied the report for nine months and in February 1989, began to develop a strategy for the implementation of ATV in the United States.[30] AEA pointed out at a Congressional subcommittee hearing that the profit margin in television consumer electronics is only 2-to-3 percent and that the break-even point in this particular market would be ten years away, well into the next century.[31] Pat Hubbard, vice president of AEA, said, "This is the kind of long term horizon that, frankly, is alien to United States industry and, I might suggest, to United States Government. It is commonplace to Japanese Government."[32] This reflects the manufacturer's point of view that they were not going to take a risk unless they had help.

The NTIA pointed out that some adjustments could be made to assist in the implementation of HDTV. Antitrust laws were seen as unduly restrictive of potential joint efforts. Government needed to take the lead to encourage or fund consortiums of private industries. Trading practices needed to be examined as well as the capital costs for risk sharing. Tax policies needed to be changed to encourage research and development efforts. Finally, non-defense applications needed to be encouraged through incentives to help focus technological efforts.[33]

Other battles were being fought in the broadcasting arena. In 1979, the Association of Maximum Service Telecasters (MST), which is an organization

made up of over 260 local television stations, unsuccessfully lobbied the FCC to prevent reallocation of a portion of the spectrum. Subsequently, the MST and the NAB were successful in persuading the FCC to save spectrum for possible HDTV broadcast. In 1987, the MST and the NAB successfully demonstrated an over-the-air broadcast of HDTV in Washington, D.C.[34]

At the time, the FCC was considering allocating part of the UHF spectrum to "land mobile" radio users. When interest developed in HDTV, the television broadcasters issued a call to arms to prevent the FCC from allocating spectrum portions to mobile radio users.[35] The MST and 57 other parties petitioned the FCC for ATV spectrum. In August 1987, the FCC issued its first *Notice of Inquiry* for an Advanced Television System asking for comments on an advanced television system (ATV) and freezing the allocation of the UHF spectrum.[36] Seventy companies or organizations responded.[37] Concurrently, the House of Representative's Subcommittee on Telecommunications and Finance requested comments on the effects of HDTV, 34 respondents filed reports. Fourteen of those had also filed with the FCC.[38]

On November 17, 1987, the FCC created an Advisory Committee on Advanced Television Service (ATS) with the purpose of advising the FCC on ATV technical and public policy issues. Part of the committee's mandate was to work with the Advanced Television Test Center (ATTC) which was testing proposed HDTV formats.[39]

Originally, 15 companies initiated 24 HDTV proposals.[40] Two events occurred that narrowed the field to six proposals. First, on September 1, 1988, the FCC issued a *Tentative Decision and Further Notice of Inquiry*.[41] The guidelines were as follows: (1) ATV should be a terrestrial-based system; (2) ATV should be received by the public as quickly as possible assuming that

broadcasters are permitted to implement ATV; (3) ATV should operate within the current VHF and UHF bands; (4) ATV should be compatible with the current NTSC standard; (5) ATV systems which require more than 6 MHz to broadcast would be unacceptable; (6) ATV is in the public interest not to slow down independent introduction of ATV services or the development applications of HDTV for "non-broadcast media;" and (7) the FCC would continue its moratorium on UHF spectrum grants to land-mobile users.[42] A second event that eliminated some proposals was the introduction of digital transmission technology by General Instrument.

The remaining six proposals were sent forward. The Advanced Television Service Committee (ATSC) established a testing schedule (see Appendix A). The last test should be completed by the end of February 1993.[43] The ATSC is to make a recommendation to the FCC after the completion of all tests.

Cable system operators became involved in the debate when it appeared that the FCC might make a ruling that would affect them. They were quick to point out that cable, through fiber optic technology, could adapt more easily to an ATV system than over-the-air technology. They also noted that there could be two different standards: one for over-the-air transmissions and one for cable. However, they generally supported a national broadcast standard.[44]

Congress began its action on ATV by conducting hearings. On October 8, 1987, the Subcommittee on Telecommunications and Finance of the House of Representatives Committee on Energy and Commerce held its first hearing on HDTV.[45] The first HDTV hearing in the Senate, on May 16, 1989, was conducted by the Subcommittee on Science, Technology and Space of the Committee on Commerce, Science, and Transportation.[46]

During the hearings, AEA and other private sector groups argued for support from the government. One proposal asked for $300 million in direct funding for HDTV research and $1 billion in government loans to assist companies in the manufacturing of HDTV equipment. In addition, they asked for tax breaks and relief from antitrust regulations.[47] Congress viewed this as an opportunity for a joint government/industry cooperative similar to Sematech, which is a government consortium in semiconductor manufacturing. Industry analysts point to Sematech as one reason the U.S. semiconductor manufacturers surpassed the Japanese chipmakers in 1992 and will probably do so in 1993.[48] Some argue that consortiums should only be involved with cutting-edge technology like superconductors rather than televisions.[49] However, for the most part the government's efforts were welcomed. James Tietjen, president of the Sarnoff Research Center, said, "The government has shown some leadership. The real hurdle will be, will American industry take advantage of it?"[50]

The development of HDTV policy was slowed because it was caught between two different administration ideologies. During the Reagan administration, antitrust barriers were relaxed and Sematech was established. But in 1988, the Bush Administration did not want to give the appearance of establishing an "industrial policy." Robert Mosbacher, Secretary of Commerce, embraced HDTV and said it was near the top of his list. He said he would institute a national plan for implementation. He was reprimanded by White House officials because he "sounded like an industrial-policy advocate, and the HDTV plan was never released."[51]

While the executive branch was worried about the label of "industrial policy," Congress assisted HDTV research and development with incentives provided by the Defense Advanced Research Projects Agency (DARPA). In

1989, DARPA announced a $30 million three-year program on a high resolution display system. Congress appropriated $20 million in the fiscal 1990 budget toward research and development, but stipulated that the Administration had to develop an HDTV program.[52]

The "industrial policy" debate within the executive branch developed more momentum when funding was questioned for Sematech and DARPA. It appeared at one point that funds would be cut by the Bush Administration. The Office of Management & Budget (OMB) became involved and stated that its position was to "halt ... defense programs with potential commercial spin-offs because they raise the specter of an 'industrial policy.' Says a senior OMB aide: 'We just don't believe in picking specific winners and losers.'"[53] Representative Don Ritter (R-Pa.) argued, "What people in the Administration haven't seen is that the United States has an industrial policy. It is simply a witless one."[54]

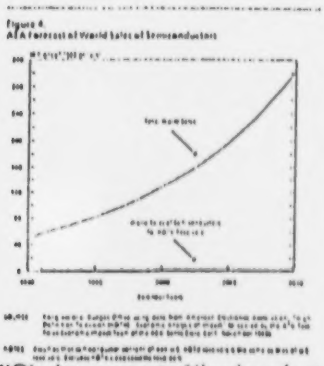
In April 1991, at Congress' request, the White House Office of Science and Technology Policy released a list of 22 critical technologies. HDTV was on the list. Interestingly, the list featured technologies rather than industries, a more neutral approach in terms of an industrial policy. Some members of Congress argued for support of industries over technologies.[55]

HDTV reflects the technology versus industry debate. Is it the technology that is being preserved or is it the rebirth of the television industry in this country? One might argue that any list that is compiled automatically selects winners and losers by the process of inclusion or exclusion. One observer argued, "[A]n approach other than industrial policy is needed to address national interests in areas such as generic technologies. The HDTV debate ... demonstrate[s] the need to develop stronger multilateral

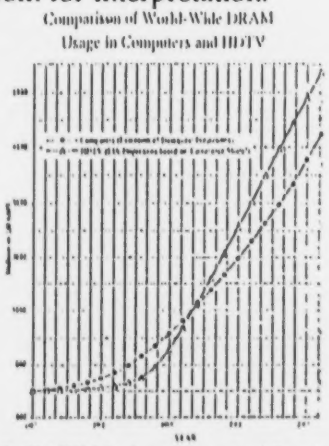
mechanisms to address differences in industrial practices and structures that affect trade and market access."[56]

Critical to HDTV are the questions of use and marketability. In 1989, the Congressional Budget Office (CBO) issued a controversial report on HDTV. Its purpose was to answer: Will there be a large market for HDTV receivers; and is this market crucial to the competitiveness of the United States electronics sector? CBO found that the market size for HDTV was "optimistic" and stated that "some skepticism about the timing, if not the eventual size, of HDTV's market success seems warranted."[57]

In its answer to the second question, CBO stated that claims had been made about technologies serving as "'technology drivers' for the rest of the electronics sector and that a network of common technology and components makes the knowledge gained in HDTV useful in other major electronics goods. But these advocates have presented little concrete evidence for this belief."[58] One example where the CBO report differs from other projections is in the area of projected semiconductor use in HDTV (see illustration 2 & 3). As can be seen from the graphs, there is room for interpretation.



Ill. 2 -CBO's Assessment of Semiconductors



Ill. 3 -DARPA's Assessment of Semiconductors

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EIA in its response to the CBO report argued that CBO examined HDTV's potential too narrowly. EIA stated that HDTV technology will more than likely utilize "flat panel displays," which will require more semiconductors than CBO projected. The second aspect is that HDTV will eventually merge with computer workstations, and this will increase the number of semiconductors used.[59]

CBO was not the only group that raised concerns about HDTV. MIT conducted a study that asked consumers about HDTV. One finding was that Americans are more demanding in terms of program material than the quality of the picture.[60] In another consumer test of stereophonic sound on television, the participants claimed that the television with the stereo sound had a better picture.[61] Others such as Arthur Tauder, senior vice president at McCann-Erickson Worldwide Advertising, reflect sort of a "ho-hum" approach toward HDTV. Tauder said, "Advertisers are not going to drive this [HDTV]. It's just not seen as that big a leap, the way color was."[62]

To summarize, the television industry can be viewed as enjoying its independence and yet wanting the government to take the lead. Both broadcasters and manufacturers were reticent to get involved in the HDTV process. Broadcasters and industry were complacent with their 6 MHz signals and Zenith was the only television manufacturer left. They needed to be awakened if HDTV was going to be a reality in the United States.

Shortly after the rejection of the 1125/60 international standard, domestic policy changed. In fact, an argument can be made that this rejection was the catalyst for beginning to develop a domestic standard. The process for establishing an HDTV policy was long and difficult. NTIA and the FCC began separate investigations of ATV systems. When the "Darby Report" was issued and given to electronics industries the private sector began to take

action by seeking assistance from the FCC. The FCC issued its first *NOI* and various private and government committees were created to study ATV.

Congress began investigating ATV systems partly because of the interest generated by the private sector and NTIA. The hearings brought forward many national concerns and much information about ATV. At the height of the Congressional hearings, a presidential election occurred. The Bush Administration was determined to avoid the impression of desiring an "industrial policy," which created some problems in the development of ATV. Despite the "industrial policy" arguments, the government did fund some HDTV research.

The government, by happenstance, goaded the private sector into taking the plunge into ATV. The private sector took action, exceeding prior developments of HDTV technology.

Summary and Conclusions

On December 7, 1941, the United States was disgraced by a surprise attack from the Imperial forces of Japan. That crisis unified the government, industry, and people of the United States by generating an unprecedented war effort. Because of that war effort, America was in better financial shape at the end of the war than at the beginning. American industries emerged as victors in the global marketplace.

Once again the United States is responding to a crisis situation. Until the mid-1980s, American television industries were complacent. Rather than developing their own HDTV system, they recommended that the Japanese 1125/60 system be adopted. Only when the Europeans rejected the 1125/60 standard did the alarm sound. The Department of Commerce, the Department of Defense, the FCC, and Congress issued calls for action to

American industry. Forces were put into action to develop a domestic HDTV standard. From the government's perspective, the technological stakes were too great to allow this opportunity to rest in foreign hands.

HDTV competition is a global concern. The Europeans are debating the direction they need to go with a digital system. They certainly protect their market from outside competition through their patent license structure. For now, their efforts do not appear to be a technological threat to the HDTV industries in the United States. There is a possibility that the United States may be an HDTV exporter to Europe, because of the connections which exist with Thomson Consumer Electronics (see Appendix B).

On the other hand, the Japanese have invested a great deal of time and money in HDTV, especially when compared to Europe and the United States. They mapped out a concept as to what this technology involves and how it should be implemented. Paul Safflo, a research fellow at the Institute of the Future, Menlo Park, California, said, "Japan's approach is like spring rain."[63] In other words, it is gentle, consistent, and appears to be never-ending. This certainly is descriptive of its HDTV efforts. Regardless of what the United States or Europe does, one can be certain the Japanese will continue to compete in the manufacturing of HDTV receivers and other equipment, no matter what the standard.

In this country, the industrial policy issue is a real concern and not just from a partisan politics perspective. If the government were to endorse industries in the high technological environment, how could it predict what is going to succeed? This is dangerous with new industries. However, if the government endorsed or encouraged technologies that are in the national interest, the risks would be spread out over several different industries. The industrial policy issue apparently has worked for Sematech.[64] For example, in

the case of HDTV, a company may build HDTV domestic receivers on one production line and build high resolution medical terminals on another line using similar technology.

FCC Commissioner Ervin Duggan recently stated that the U.S. can no "longer disavow industrial policy." His three-part test for an industrial policy to be evaluated as good or bad includes: (1) [D]oes it have a "multiplier effect," creating a "gigantic boom for a relatively small investment;" (2) does it "revere private initiative and private market forces;" and (3) does it create "arenas for competition" among many companies.[65] His test could certainly be applied to some type of HDTV policy.

Lewis Branscomb, the Albert Pratt Public Service Professor at the John F. Kennedy School of Government at Harvard University, makes the argument that the United States does have a technology policy, but it needs to be greatly clarified.[66] He is not for eliminating competition or for industries to compete against government sponsored research, but supports encouraging industry to take on a more advisory position with government. In other words, allow industry to begin a dialogue with government to keep government informed as to what industries' problems are. As a result, the government would not always be responding to a crisis and it might cost less money or at least spread the cost over time.

Branscomb's concept can be applied to HDTV. Television industries could have gone to the government with an HDTV proposal in the first place. Then they could have explained the technology and their plans to implement it. The government would not be in the position that it is in today. Business has to feel comfortable working side by side with government agencies. In this country we have an interesting cycle which has to be broken if we are going to compete globally. The private citizen distrusts business; business

distrusts government; and when government enters an arena it often hurts more than it helps.

The FCC perhaps for the first time in the history of broadcasting is forcing a technology on the broadcasters. In the past when competing media were developed, such as AM vs. FM or FM stereo vs. regular FM, the FCC did not prescribe that competition cease. The technologies coexisted side by side. However, with ATV the FCC has stated that when ATV becomes the "prevalent medium," which is targeted by the FCC to be in 2008, it will require stations to cease broadcasting in NTSC and further licenses will not be issued.[67] Broadcasters will have 15 years from the time an HDTV standard is adopted to acquire a channel and build a station (three years to apply for a license and 12 years to get the station functional) and then the NTSC version will go dark.[68]

The broadcasters' reaction to this move by the FCC is perhaps best summarized by Bruce McGorrill, chief executive for WCSH-TV, "We're going to be forced to spend $5 to $10 million, with little or no opportunity to recoup that investment for a long time. And, say 15 years from now, we will be back in an increasingly multichannel environment, but with an enormous debt load."[69] Alfred Sikes, chairman of the FCC, takes the position, "Every industry that has failed to upgrade its plant is dead or dying ... now is not the time to get weak-kneed. Weak-kneed individuals and industries fall behind in dynamic markets."[70]

American companies have risen to the challenge of developing what appears to be a superior system. Broadcasters are being forced to go along. In the case of HDTV, American companies have done what they do best: Rise to the challenge. Unfortunately, they have yet to meet the real test: To demonstrate ways of innovating HDTV products in the marketplace. The

first step is closing in with adoption of a transmission standard in 1993. The second step, formulating a technology policy, will be more difficult.

Appendix A - Proposed Testing Schedule

FCC Advisory Committee on Advanced Television Service
Actual / Projected Test and Report Schedule

	ATTC / CableLabs Test and Report Schedule					ATEL Test and Report Schedule			Proponent Final Comments	Data Analysis Schedule		
	Start ATTC Test	End ATTC Test	Start CableLabs Test	End CableLabs Test	Draft Report to Proponent	Start ATEL Test	End ATEL Test	Draft Report to Proponent		Data Analysis Begins	System Report Complete	SS/WP4 Adopts Report
ACTV	12 Jul 91	15 Sep 91	16 Aug 91	22 Aug 91	29 Jan 92	3 Sep 91	10 Feb 92	13 Feb 92	T.B.D.	N/A	N/A	N/A
N-MUSE	20 Sep 91	18 Nov 91	16 Oct 91	22 Oct 91	3 Apr 92	4 Nov 91	3 Feb 92	28 Feb 92	17 Apr 92	24 Apr 92	15 May 92	29 May 92
DigiCipher	10 Dec 91	28 Feb 92	27 Jan 92	31 Jan 92	8 May 92	17 Feb 92	31 Mar 92	14 Apr 92	22 May 92	29 May 92	19 Jun 92	6 Jul 92
DSC-HDTV	9 Mar 92	8 May 92	20 Apr 92	24 Apr 92	6 Jul 92	15 Apr 92	5 Jun 92	19 Jun 92	20 Jul 92	27 Jul 92	17 Aug 92	31 Aug 92
AD-HDTV	19 May 92	15 Jul 92	22 Jun 92	26 Jun 92	9 Sep 92	15 Jun 92	3 Aug 92	17 Aug 92	23 Sep 92	30 Sep 92	21 Oct 92	4 Nov 92
CC DigiCipher	24 Jul 92	18 Sep 92	17 Aug 92	21 Aug 92	16 Oct 92	20 Aug 92	8 Oct 92	23 Oct 92	6 Nov 92	13 Nov 92	4 Dec 92	18 Dec 92
ATEL Summary										13 Nov 92	4 Dec 92	18 Dec 92

March 31, 1992

Dates before March 30, 1992 are actual dates; dates after March 30, 1992 are projected dates. Testing times are estimated and do not include any contingency time for equipment failure or test procedure changes.

Start ATTC Test and End ATTC Test dates were determined after the SS/WP2 decisions on 18 Mar 92. Audio testing is included in the ATTC test slot. Start CableLabs Test and End CableLabs Test dates are assumed to be in the "middle" of the ATTC test slot for the last two systems. ATTC / CableLabs Draft Report to Proponent date is two months after End ATTC Test except for the last test slot which is one month. The audio report (by the contractor, Westinghouse) is included in the ATTC report.

Start ATEL Test and End ATEL Test and ATEL Draft Report to Proponent dates were determined after the SS/WP2 decisions on 18 Mar 92. The ATEL dates assume that the ATTC dates do not change, that one week's worth of tapes (three tests) are made by the end of the second week at ATTC, and that an uninterrupted flow of the balance of the tapes (three tests/week) follows over the next four weeks (including the CableLabs tapes).

Proponent Final Comments date is two weeks after the last individual draft report is given to the proponent. The proponent may have portions of the report for more than two weeks but will have the entire report for only two weeks. This date is the deadline for proponents to file their final comments on the report prior to printing.

Data Analysis Begins date is one week after Proponent Final Comments date. This is the date that members of PS/WP3 and the SS/WP4 Task Force on Data Analysis should have the test reports in their hands and can begin to analyze the data.

System Report Complete allows three weeks for data analysis to be performed by PS/WP3 and the SS/WP4 Task Force on Data Analysis and for draft text to be written on the test results for inclusion in the SS/WP4 final report.

SS/WP4 Adopts Report allows two weeks for distribution of the data analysis draft to SS/WP4 and for study of the draft by SS/WP4 members prior to the SS/WP4 meeting at which the data analysis report will be adopted.

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Appendix B - Proposed Digital HDTV Systems

The proposed systems are: Advanced Digital-HDTV (AD-HDTV); Digital Spectrum Compatible High Definition Television (DSC-HDTV); DigiCipher; Channel Compatible DigiCipher (CC-DigiCipher); and Narrow-Multiple Sub-Nyquist Sampling Encoding Scheme (N-MUSE).

Advanced Digital-HDTV(AD-HDTV)

The AD-HDTV proposal is being developed by the Advanced Television Research Consortium (ATRC). It is comprised of the David Sarnoff Research Center, the French-owned Thomson Consumer Electronics, the National Broadcasting Company, North American Philips, and Compression Labs.[71] The heart of ATRC is the David Sarnoff Research Center (formerly the RCA Research Laboratories), which began research on HDTV in 1977.[72]

The Sarnoff/RCA center spent over $40 million on the initial research and development of ACTV-I and ACTV-II and proposes to spend another $35 million to complete the project.[73] ACTV-I was designed to be compatible with current NTSC standards except it provided 1050 scan lines. It would operate in the regular 6 MHz bandwidth. ACTV-II included 1050 scan lines, an aspect ratio of 16:9, digital audio, and required an additional 6 MHz channel.[74] Both transmission systems were primarily analog with some digitization aspects.

ACTV-I and II developed problems when the FCC issued its *First Report and Order* on August 24, 1990.[75] The FCC determined that only proposals that used a "simulcast" system would be acceptable. Simulcast is defined as "the broadcast of one program over two channels to the same area at the same time."[76] ACTV-I and II had to be redesigned for simulcast, thus the two systems were merged under the new name of ACTV.[77]

In January 1992, the ATRC began testing the digital version, AD-HDTV, but ran into problems. Parts of the system would not interact. This lead to a delay by the Advanced Television Test Center (ATTC). The group completed its testing in December 1992.[78]

From its beginning, critics of ACTV have argued that adoption of this system "may close the door forever on broadcasters' ability to deliver true, high-definition television."[79] The criticism is aimed at ACTV being "shoehorned" into the 6 MHz spectrum. By doing so, full HDTV capabilities may not be explored. Another concern is the extra expense to the broadcaster. In order to acquire the HDTV signal an extra transmitter, antenna, and studio-transmitter equipment would have to be purchased. Generally, broadcasters have been critical of all the approaches to HDTV calling the technology "High-deficit TV."[80]

In September 1992 the ATRC simulcast an HDTV signal over NBC's WRC-TV, channel 4 and the HDTV signal was over channel 38. The test results were praised as very good.[81]

Digital Spectrum Compatible High Definition Television (DSC-HDTV)

The DSC-HDTV proposal is being developed by a consortium of Zenith and American Telephone and Telegraph (AT&T). Zenith is responsible for system development and transmission technology. AT&T is responsible for video compression and engineering the integrated circuits.

DSC-HDTV is similar to ACTV and would simulcast a standard NTSC signal on one channel and an enhanced signal over another channel.[82] This system would include an aspect ratio of 16:9,[83] and progressive scanning of 787.5 scan lines.[84] Zenith argues that this format is equivalent to seeing 1575 lines every 30th of a second.[85]

In May 1992, Zenith broadcast its DSC-HDTV signal 75 miles from Milwaukee to Glenview, Illinois. Zenith was able to demonstrate that HDTV was possible with low power transmission, was free from co-channel interference, reduced interference to a co-channel NTSC station, had the ability to record and play HDTV from a 525-scan videotape recorder, could be produced with a progressive scan camera, and could convert an ordinary NTSC picture to a widescreen NTSC picture.[86]

The test did not eliminate what is known as the "cliff effect." In analog transmission the signal fades gradually in relation to the distance between the receiver and transmitter. Bad weather or difficult terrain may also cause the signal to fade in and out. Given the same conditions using digital transmission, the entire picture or sound will be cut off when the binary signal begins to fade. This has been compared to falling off a cliff.[87] This is a problem with all digital transmission systems.

Zenith has invested over $50 million in research of DSC-HDTV.[88] Zenith claims that starting in 1994 a 27-inch receiver might sell for between $1,000 and $2,000.[89] It projects that sales could reach 1 million sets annually by 1996.[90] It should be noted that Zenith is the sole television set manufacturer in the United States. In reference to the FCC's pending decision in 1993, Jerry Pearlman, Chairman of Zenith, stated, "[w]e think it will be us."[91]

DigiCipher and Channel Compatible DigiCipher (CC-DigiCipher)

DigiCipher and CC-DigiCipher are being developed by the American Television Alliance (ATVA). This group is composed of General Instrument (GI) and the Massachusetts Institute of Technology (MIT).[92] These are the last two proposals to be tested by the ATTC. Testing should be completed in 1993.

Prior to General Instrument's proposal, MIT had two digital systems that it advocated: MIT-RC and MIT-CC. The concept of both systems was virtually the same using progressive scanning. The camera, transmitter and receiver could all use different scanning standards and frame storage systems and still be compatible. The receiver would be a "smart" receiver with open architecture that could be programmed to improve the signal.[93] "MIT states that such a programmable receiver could easily adapt decoding parameters to different TV transmissions, including NTSC, and would allow further

additions such as motion-compensated temporal interpolation, echo cancelling, and noise reduction."[94]

General Instrument entered the arena with its demonstration of DigiCipher at the International Broadcasting Convention in Brighton, England in September 1990.[95] Its system was developed out of the company's method of digitizing satellite interlaced television transmissions. The key was data compression. Using a 6 MHz terrestrial television channel, DigiCipher could carry one HDTV program or five conventional programs. The same technology would allow a satellite to transmit two channels of HDTV or ten channels of regular television.[96]

MIT and GI combined forces to speed up research. The compression process is lengthy. According to GI, it takes 1,000 minutes to process one minute of HDTV and with MIT's assistance the compression time has been reduced.[97] The system now uses a progressive scan process that allows for a sharper image, but it is more complex and costly.[98]

The Channel Compatible DigiCipher system adds one more dimension to solve some of the digital transmission problems. It uses cellular-type towers primarily to avoid ghosting problems encountered with digital signals in large cities. Ghosting occurs when a single high-power transmitter is used. The cellular concept would involve scattering transmitters around to assist the signal so that there is no signal loss.[99] This would also remedy the "cliff effect" of digital transmissions.[100]

Because the system is built on cells, a broadcaster could add cells as needed. CC-DigiCipher proponents argue that this would accelerate HDTV implementation. This approach, however, would be more expensive for a UHF station than a VHF station because of the increased power necessary for a UHF signal. This could mean higher operating costs for a UHF station over a VHF station.[101]

Robert Rast, GI vice president for HDTV, said "Digicipher achieves a balance among performance, portability and competitive cost."[102] GI field tested its signal in San Diego in September 1992 with good results.[103]

Narrow-Multiple Sub-Nyquist Sampling Encoding Scheme (N-MUSE)

NHK, the Japanese Broadcasting Corporation, has the most experience in developing an HDTV system. Dr. Takashi Fuji coordinated the effort toward developing a "Hi Vision" television system in the late 1960s.[104] NHK has spent over $150 million on the development of HDTV with an additional amount from the private sector.[105]

The MUSE system emerged in 1984. It included an aspect ratio of 16:9, 1125 scan lines, a 30-MHz bandwidth, four audio channels, and distribution via satellite because of the bandwidth.[106] On November 25, 1991, the Japanese began broadcasting eight-hours of daily programming with MUSE from its BS-3 satellite.[107]

When the United States began pursuing HDTV in the mid-1980s, the Japanese gladly demonstrated the MUSE system. By 1985, SMPTE supported

adoption of MUSE as a production standard.[108] As previously noted, however, the MUSE system was rejected internationally.

As the United States became more involved with HDTV, NHK offered four different versions of MUSE.[109] But because of the FCC's decision to insure that HDTV would be NTSC compatible, the only Japanese version left was the Narrow MUSE system. N-MUSE is NTSC compatible, provides two channels of digitized audio, has a 1125 interlaced scan, has a 16:9 aspect ratio, and can be simulcast on two 6 MHz television channels.[110] The system is largely an analog transmission standard with digitized audio.[111]

The working party of the Advisory Committee of Advanced Television Service has determined that the Narrow-MUSE system can only accommodate 92.6% of the 1,699 television stations preselected for HDTV. NHK has responded by saying that the system is now 100% compatible.[112]

Summary

Certain key elements or suggestions by the FCC and research consortiums such as MIT yield several clues as to what the HDTV standard might include. Clearly the transmission system will be digital. Digital has certain advantages: It requires less power, occupies less bandwidth, and is more precise than analog systems. Also, the FCC has begun to set standards. For example, the system will be terrestrial based, will be NTSC compatible, will have more than 1000 lines, will be based on a 60 Hz cycle, will be simulcast using 6 MHz bandwidth, and will use digital high-fidelity sound.

The consortiums of the six proposed systems are interesting. One group has a television manufacturer and a phone company working side by side; another group has a major data compression company aligned with a major research university; and another group is a major electronics research lab combined with the NAB, a television network and a French consumer electronics firm. Why would such a mixture of interest groups express an interest in HDTV when television set manufacturing has such a low profit margin?

One obvious answer would be to recover some of their research and development costs. To reduce their risks, the consortiums have entered into royalty-sharing agreements. The Zenith/AT&T consortium has signed an agreement with the General Instrument/MIT consortium to share royalties should either group's standard be selected.[113] This basically divides the domestic developers into two groups based on royalty agreements: Sarnoff, *et al*, on one side and Zenith/AT&T/General Instrument/MIT on the other.[114]

Another reason that the companies are interested in HDTV is the various spin-off technologies. Companies such as AT&T and GI are looking at HDTV as a means to position themselves as distributors of video information.[115] With the chip technology and know how in place, they can recover research and development costs, as well as set the standards that will bring in revenue from patent licensing.

At this point, the competitors are requesting of the FCC retest in February. Each of the systems have produced acceptable results and since the

initial test have improved on their respective systems. The only problems so far are those that accompany a digital system. MIT's system claims to have a three-in-four chance of being selected because of the agreements.[116] If the Zenith system is selected and because of the patent agreement with GI and MIT, it would not be surprising to see a cellular concept added to the system. However, the Sarnoff group and the Zenith group "are seeming to make the systems look more alike."[117] The winner will be announced on Feb. 24, 1993 by the FCC. PBS, MST and Cable Television Laboratories will begin field test of the winning system immediately.[118]

NOTES

[1]A. Lippman, *HDTV Sparks a Digital Revolution*, 15 BYTE 297, 299 (Dec. 1990) [hereinafter *HDTV Sparks*].

[2]"If television can be compared to an addictive drug, high-definition television (HDTV) is an "hallucinogen." *America's billion-dollar boob-tube battle*, The Economist 67 (May 27, 1980).

[3] *High Definition Television: Hearings Before the Subcomm. on Telecommunications and Finance of the House of Representatives Comm. on Energy and Commerce*, 100th Cong., 1st Sess. 100-188 (1987) at 4 (statement of Joseph A. Flaherty, vice president, CBS Engineering and Development) and at 204 (statement of L.S. Newman, Jr., Division Manager New Service Concepts and Tate B. Jennings, member of the Technical Staff District 22223, both of Bell Communications Research) [hereinafter *HDTV 1*]. *See also The Big Picture: HDTV and High-Resolution Systems*, U.S. Congress Office of Technology Assessment, OTA-BP-CIT-64, (1990) at 4-6 [hereinafter *The Big Picture*].

[4]*The Big Picture, supra* note 3, at 6.

[5]W. Sweet, *Future of Electronics Companies at Stake in Development of New TV Systems*, 44 PHYSICS TODAY 57, 61 (1991) [hereinafter *Future of Electronic Companies*].

[6]*See High Definition Information Systems: Hearings Before the Subcomm. on Technology and Competitiveness of the House of Representatives Comm. on Science, Space, and Technology*, 102d Cong., 1st Sess. 19 (1991) [hereinafter *Information Systems*]. *See also* A. Lippman, *HDTV Sparks a Digital Revolution*, 15 BYTE 297-305 (1990); J. Max Robins, *Live From MIT: Test Tube TV*, 8 CHANNELS 56-8 (1988); J. Nadan, *A Glimpse Into Future Television*, 10 BYTE 135 (1985); and S. Brand, THE MEDIA LAB: INVENTING THE FUTURE AT MIT (1987).

[7]Beginning on Oct. 8, 1987 and lasting through 1991 there were at least 13 days of various Congressional subcommittee hearings devoted to HDTV. Eleven days of hearings occurred in 1989 and this does not include the various National Telecommunications and Information Administration reports and the Office of Technology Assessment reports. Additionally, on July 16, 1987 the Federal Communication Commission issued a *Notice of Inquiry, In the Matter of Advanced Television Systems and Their Impact on the Existing Television Broadcast Service*, MM Docket No. 87-268, 2 FCC Rcd 5125 (1987) [hereinafter *In re ATVS*] which opened the door for broadcasters and other interested parties to file their opinions about an advanced television system.

[8]A. Tocqueville, DEMOCRACY IN AMERICA (1835).

[9]*The Big Picture, supra* note 3, at 34.

[10] "[T]he reason that I believe HDTV laid fallow in this country in terms of interest from industry was it wasn't a practical application." *HDTV 1, supra* note 3, at 185 (statement of Steven Bonica, Vice President of Engineering for the National Broadcasting Company).

[11]Motorola was encouraged by the Eisenhower administration to assist the Japanese with their economic development. The company did well at first but was not able to establish a joint venture with the Japanese until 1980. Other companies like GE and RCA were more successful by licensing their patents to make black and white TV sets in Japan. C. Prestowitz, Jr., TRADING PLACES: HOW WE ARE GIVING OUR FUTURE TO JAPAN AND HOW TO RECLAIM IT, 338-358 (1989) [hereinafter TRADING PLACES].

[12]In 1970, the Treasury Department filed suit against the Japanese for "dumping" television sets on the American market. *Id.* 338-358. The Department of Commerce eventually took over the suit and in 1980 reached a settlement with the Japanese for around $76 million, which was less than one year's price kickback, (*Id.* at 357) or in other words, the Japanese fine was 1.6 cents on the dollar. *High Definition Television, Hearings Before the Subcomm. on Telecommunications and Finance of the House of Representatives Comm. on Energy and Commerce,* 101st Cong., 1st Sess. 101-34 (1989) at 188 (statement of Pat Choate, Vice President of Policy Analysis for TRW, Inc.) [hereinafter *HDTV* 2]. When the Commerce Department appealed the case to the U.S. Supreme Court, the Treasury Department along with the Justice Department and the State Department filed *amicus curiae* briefs on part of the Japanese, which caught many observers of the situation off guard. Motorola wondered whose side the government was on. TRADING PLACES, *supra* note 11, at 338-358. *See also* U.S. Industrial Competitiveness: A Comparison of Steel, Electronics, and Automobiles, U.S. Congress Office of Technology Assessment at 114-6 (1985).

[13]*The Big Picture, supra* note 3, at 1.

[14]*May the Best High Definition Television System Win,* 10 CHANNELS 54, 55 (Aug. 1990).

[15]*The Big Picture, supra* note 3, at 49.

[16]*Id.* at 30.

[17]*Id.*

[18]The ATSC was formed in 1982 by the National Association of Broadcasters (NAB), the Association of Maximum Service Telecasters (MST), the Institute of Electrical and Electronic Engineers, the National Cable Television Association, SMPTE, and the Electronic Industry Association The main charge was to make recommendations to the State Department in developing standards for the CCIR. Also it was to assist with the development of HDTV and encourage the private sector in the development of HDTV. *HDTV: The International HDTV Standard-Setting Process and the Role of International Standards on U.S. Competitiveness, Subcomm. on Int'l Scientific Cooperation House of Representatives Comm. on Science, Space and Technology,* 101st, 1st Sess. 42 (1989) at 12 (statement of James C. McKinney, chairman of ASTC) [hereinafter *HDTV Int'l*] .

[19]*HDTV Int'l, supra* note 18, at 12.

[20]*Id.*

[21]In January 1989, CBS aired *Littlest Victims,* a docudrama about children with aids that was shot in HDTV. *Crack in the Mirror,* a movie shot on HDTV and transferred to film, was produced by Barry Rebo, who had one of the first HDTV studios in the country. P. Cole,

How Does Hollywood Zap A Planet? With High-Definition Help, BUSINESS WEEK 62 (Jan. 30, 1989). Another HDTV studio is 1125 Productions owned by David Niles who produces mostly commercials. S. Behrens, *Suddenly, TV's Overhaul Gets Priority Treatment,* 7 CHANNELS 90 (1988) [hereinafter *Overhaul*]. The Canadian Broadcasting Corp. debuted its miniseries entitled *Chasing Rainbows* produced in HDTV in April 1988. S. Behrens, *Passage to High-Def,* 8 CHANNELS 54 (1988). A new HDTV production facility is planned for Los Angeles in 1993. P. Lambert, *HDTV Center to Open in L.A.,* BROADCASTING 65 (Dec. 14, 1992).

[22]*See infra* text accompanying notes 64-69.

[23] *The Big Picture, supra* note 3, at 35.

[24]*See, e.g., supra* notes 11-12.

[25] F. Seghers, *Television Makers Are Dreaming of a Wide Crispness, BUSINESS* WEEK 109 (Dec. 21, 1987).

[26]*HDTV 2, supra* note 12, at 17 (statement of Robert A. Mosbacher, Secretary, Dept. of Commerce).

[27]*Id.* at 52. *See also First Report, infra* note 75, at 5627.

[28]*Notice of Inquiry: Inquiry on Production Standards for High Definition Television,* 53 Fed. Reg. 51,296 (1988).

[29]*High Definition Television, Hearing before the House of Representatives Comm. on Science, Space, and Technology,* 101st Cong., 1st Sess. 12 (1989) at 70-75 (statement of Alfred C. Sikes, Assistant Secretary for Communications and Information, NTIA, Dept. of Commerce [hereinafter *HDTV* 3].

[30]*High Definition Television, Hearing before the Research and Development Subcomm. and the Investigations Subcomm. of the House of Representatives Committee on Armed Services,* 101st Cong., 1st Sess. 101-61 (1989) at 65 (statement of Pat Hubbard, Vice President, American Electronics Assoc.) [herinafter *Armed Services*].

[31]*Id.* at 67.

[32]*Id.*

[33]*HDTV 3, supra* note 29, at 88.

[34]*HDTV Int'l, supra* note 18, at 97 (statement of Joel Chaseman, chairman, Post/Newsweek stations, Association of Maximum Service Telecasters).

[35]S. Behrens, *High-definition's spectrum needs spur TV broadcasters to action,* 6 CHANNELS 16 (April 1987).

[36]*In re ATVS, supra* note 7.

[37]These companies or organizations are: A-Vision, Inc.; American Family Broadcast Group, Inc.; A. of Independent TV Stations, Inc.; A. of Maximum Service Telecasters; Black TV Workshop of L.A.; Blonder Tongue Labs, Bonneville Int'l Corp.; Broadcasting Technology A., Japan; Bundy, Jr., Walt W.; Capital Cities/ABC, Inc.; CBS, Inc.; Center for Advanced TV Studies; Chronicle Broadcasting Co.; Corp. for Public Broadcasting, Nat'l A. of Public TV Stations, and Public Broadcasting Service; Cosmopolitan Broadcasting Corp.; Cosmos Broadcasting Corp. and M & C Comm., Inc.; Cox Enterprises, Inc.; David Sarnoff Research Center, Inc.; Del Rey Group; Digideck, Inc.; Dolby Lab.; Electronic Industries A., Consumer Electronic Group; Electronic Industries A., Satellite Comm. Section; Faroudja Labs; Fisher Broadcasting, Inc.; G.E. Consumer Electronic Business; Gen. Instrument Corp.; George N. Gillett, Jr.; Great American Broadcasting Co., McGraw-Hill Broadcasting Co., Inc., and The N. Y. Times Co., Hearst Corp.; Hitachi, Ltd., Cen. Research Lab; Hughes Comm. Galaxy, Inc.; Japan Broadcasting Corp.; Japan Satellite Broadcasting; King Broadcasting Corp.; Land Mobile Comm. Council, Drafting Committee; Matsushita Electric Corp. of America; Meredith Corp.; Metrovision, Inc., Newchannels Corp. and Sammons Comm., Inc.; Motion Picture A. of America, Inc.; Nat'l A. of Broadcasters; Nat'l Black Media Coalition and the NAACP; Nat'l Broadcasting Co., Inc.; Nat'l Cable TV A., Inc.; Nat'l Captioning Institute, Inc.; Nat'l Public Radio; Nat'l Telecommunications and Information Administration; Neuman, W. Russell; N.Y. Institute of Technology; Nippon TV Network Corp, Engineering & Technical Operations; N.A. Philips Corp.; Outlet Broadcasting, Inc. and Atlin Communications, Inc.; Post-Newsweek Stations, Inc.; Pulitzer Broadcasting Co.; Radio New Jersey; Radio Telecom and Technology; Radio-TV News Directors of America; Rogers Cable systems of America, Inc.; Satellite Broadcasting and Comm. A. of America; Schreiber, William F.; Scientific Atlanta; Scripps Howard Broadcasting Co.; Time, Inc.; Times Mirror Broadcasting; Toshiba America, Inc.; Tribune Broadcasting Co.; U.S. Advanced TV Systems Committee; Viacom International, Inc.; and Zenith Electronic Corp. *Tentative Decision and Further Notice of Inquiry,* MM Docket No. 87-268, 3 FCC Rcd 6520, 6541-6543 (1988) [hereinafter cited as *Further Notice*].

[38]These companies or organizations are: Advanced TV Test Center; American Electronic A.; A. of Maximum Service Telecasters, Inc.; Bellcore; Capital Cities/ABC, Inc.; CBS, Inc.; Citizens for a Sound Economy; Committee of Corp. Telecommunication Users, Citicorp/Citibank; Committee to Preserve American Color TV; Community Antenna TV A.; Corp. for Public Broadcasting; The Del Rey Group; Digital Equipment Corp.; Hugh Carter Donahue, Ph.D.; Electronic Industries A. Advanced TV Committee; Faroudja Labs, Inc.; FCC's Advanced TV Advisory Committee; Dr. William Glenn, NYIT; GTE Service Corp.; HDTV 1125/60; Institute of Electrical and Electronics Engineers, Inc.; Rep. Mel Levine, U.S. House of Rep.; MIT; Nat'l A. of Broadcasters; Nat'l A. of Public TV Stations; Nat'l Broadcasting Co., David Sarnoff Research Center, Thomson Consumer Electronics, Inc.; Nat'l Cable TV A.; One Mile Up, Inc.; Philips Consumer Electronics, N.A. Philips Corp.; Prometrix Corp.; The Public Broadcasting Service; Satellite Broadcasting and Communications A.; Semiconductor Industries A.; and Zenith Electronics Corp. *Public Policy Implications of Advanced Television System, A Staff Report for the Subcomm. on Telecommunications and Finance of the House of Representatives Comm. on Energy and Commerce,* 101st Cong., 1st Sess. 95-221 (1989) at V [hereinafter *Public Policy Implications*].

[39]*Interim Report of the FCC Advisory Committee on Advanced Television Service,* cited in *HDTV 1, supra* note 3, at 341.

[40]They were: AVELEX proposing AVLEX-HDTV; BTA proposing EDTV-I and EDTV-II; FAROUDJA proposing Super NTSC; HI RES SCI proposing HRS-CCF; IREDALE proposing HD-NTSC; MIT proposing RC and CC; NHK proposing MUSE-6, MUSE-9 NARROW MUSE, and MUSE; NYIT (Glenn) proposing VISTA; OSBORNE proposing OCS; N.A. PHILLIPS proposing

HDMAC-60, HDNTSC 6+3, AND HDNTSC 6+6; PSI proposing GENESYS; QUANTICON proposing QuanTV; SARNOFF proposing ACTV-E, ACTV-I, and ACTV-II; SCIENTIFIC ATLANTA proposing HDB-MAC; and ZENITH proposing SC-HDTV. S. Prentiss, HDTV: HIGH DEFINITION TELEVISION at 12 (1990) [hereinafter HDTV].

[41]*Further Notice, supra* note 37, at 6520.

[42]*Id.* at 6521. *See also* E. Blinder, *Closing in on HDTV*, 8 CHANNELS 54 (1989) [hereinafter *Closing in on HDTV*].

[43]*Fifth Interim Report of the FCC Advisory Committee on Advanced Television Service*, at 15 (March 24, 1992) [hereinafter *Fifth Interim Report*].

[44]*Cablers Envision Multi-standard HDTV Sets*, 8 HIGH TECHNOLOGY BUSINESS 38, 39 (1988). *See also Overhaul, supra* note 21.

[45]*HDTV 1, supra* note 3.

[46]*High Definition Television: Developing A National Technology Strategy for High Definition Television, Hearing before the Subcomm. on Science, Technology, and Space, of the Senate Comm. on Commerce, Science, and Transportation*, 101st Cong., 1st Sess. 101-378 (1989).

[47]*See, e.g., supra* note 30.

[48]J. Schneidawind, *U.S. computer chips make a comeback*, USA TODAY Dec. 9, 1992, at B1.

[49]A. Hall and O. Port, *Why High-Tech Teams Just Aren't Enough*, BUSINESS WEEK 63 (Jan. 30, 1989).

[50]*HDTV May Tune U.S. High-Tech Policy*, 32 RESEARCH TECHNOLOGY MANAGEMENT 2 (July 8, 1989).

[51]C. Beltz, *How to Lose the Race: Industrial Policy and the Lessons of HDTV*, 2 THE AMERICAN ENTERPRISE 22, 23 (1991) [hereinafter *How to Lose the Race*].

[52]*The Big Picture, supra* note 3, at 36-37. *See also* P. Gilmartin, *Lawmakers to Press for Legislation to Boost U.S. High-Definition TV Role*, 130 AVIATION WEEK & SPACE TECHNOLOGY 24 (March 27, 1989); P. Gilmartin *DARPA Poised to Award Contracts for High-Definition Display concepts*, 131 AVIATION WEEK & SPACE TECHNOLOGY 32 (Sept. 4, 1989).

[53]J. Carey, *Will The White House Torpedo America, Inc.?*, BUSINESS WEEK 80 (Nov. 27, 1989).

[54]*Id.*

[55]*How to Lose the Race, supra* note 51, at 22.

[56]*Id.* at 27.

[57]*Prospects for Development of a U.S. HDTV Industry, Hearings before the Senate Committee on Governmental Affairs*, 101st Cong., 1st Sess. S. HRG. 101-226 (1989) at 51 (statement of Robert D. Reischauer, Director, Congressional Budget Office) [hereinafter *Prospects*].

[58]*Id.* at 53. *Contra*, George Gilder argues that television is a dead technology. Instead of using HDTV as an over-the-air broadcast we should distribute HDTV programs over cable and save specturm for land use radio applications which require mobility. G. Gilder, MICROCOSM 307 (1989).

[59]*Id.* at 152-3 (statement of Peter F. McCloskey, President, Electronic Industries Association).

[60]*High-Definition TV Myths Debunked*, 8 HIGH TECHNOLOGY BUSINESS 55 (1988).

[61]*High Definition History, infra* note 104, at 300.

[62]*HDTV Homes, infra* note 77, at 109.

[63]R. Haavind, *What makes Japan's collaborative HDTV projects click?*, 16 ELECTRONIC BUSINESS 30, (January 8, 1990).

[64]*See supra* text accompanying note 48.

[65]*Duggan Calls for More Government Planning*, BROADCASTING 33 (Sept. 28, 1992).

[66]L. Branscomb, *Does America Need a Technology Policy?* HARVARD BUSINESS REVIEW 24 (March-April 1992).

[67]*In the matter of Advanced Television Systems and Their Impact Upon The Existing Television Broadcast Service*, MM Docket No. 87-268, 70 RR 2d 1118-9 (1992).

[68]J. Flint, *FCC to Inject "Flexibility" Into HDTV Timetable*, BROADCASTING 14 (Sept. 14, 1992). *See also*, J. Flint, *FCC Gives on HDTV Timetable*, BROADCASTING 5-6 (Sept. 21, 1992); P. Lambert, *HDTV's Multipuzzled Prospect*, BROADCASTING 3 (Aug. 24, 1992); H. Jessell, *HDTV Option: Multiple and Be Fruitful* BROADCASTING 28 (Sept. 7, 1992); P. Lambert, *FCC and Broadcasters Battle Toward Flexible HDTV Conversion* BROADCASTING 4-5 (Oct. 5, 1992); and P. Lambert, and J., Flint, *MSTV, FCC at Odds Over HDTV Allotments*, BROADCASTING 32-33 (Sept. 28, 1992).

[69]P. Lambert, *FCC and Broadcasters Battle Toward Flexible HDTV Conversion*, BROADCASTING 4 , 14 (Oct. 5, 1992).

[70]*Id.* at 4.

[71]*Future of Electronic Companies, supra* note 5, at 60.

[72]In 1986, RCA was purchased by GE and in 1987 the Sarnoff Center was given to SRI International that mostly does contract work for the French owned Thomson Consumer Electronics. W. Sweet, *Sarnoff Center Girds Loins for Global Competition in HDTV*, 42 PHYSICS TODAY 63, 64 (June 1989). In Dec. 1987, GE and Thomson CE made a trade. Thomson

gave GE its European medical equipment business for GE's North American consumer electronics business. This trade gave Thomson CE the domestic television capabilities of RCA and GE and made Thomson the largest television manufacturer in America. W. Sweet, *Plans for HDTV Face Vagaries of Market, Regulation and Leadership*, 44 PHYSICS TODAY 91 (April 1991).

[73] *HDTV 1*, *supra* note 3, at 169 (statement of Steven Bonica, Vice President of Engineering for the National Broadcasting Company).

[74]HDTV, *supra* note 40, at 44-50.

[75]*First Report and Order* MM Docket no. 87-268, 5 FCC Rcd 5627 (1990) [hereinafter *First Report*].

[76]*Id.* 5629 fn 1.

[77] Augmented means occupying an additional 3 MHz on an adjacent television channel. ACTV was designed to use an interlace scanning technique, which means that the image will be created by scanning every other line and then filling in the remaining lines (similar to the NTSC standard). M. Lewyn, *HDTV Homes In On the Ultimate Test: The Market*, BUSINESS WEEK 108 (April 27, 1992) [hereinafter *HDTV Homes*].

[78]*Future of Electronics Companies*, *supra* note 5, at 60. *See also* H. Fields, *ATRC delay could could* [sic] *be major set back in race for HDTV standards*, 15 TELEVISION BROADCAST 6 (June 1992).

[79]R. Rivlin, *High-Def Perplex*, 8 CHANNELS 76 (1988).

[80]*HDTV Homes*, *supra* note 77, at 108.

[81]*NBC, Sarnoff Group Provide First Public HDTV Simulcast*, BROADCASTING 15 (Oct.5, 1992) [hereinafter *NBC, Sarnoff*].

[82]*Closing in on HDTV*, *supra* note 42, p. 54.

[83]HDTV, *supra* note 40, at 50.

[84]This means that every line is painted progressively which allows for a sharper image, but it is more complex and costly. *HDTV Homes*, *supra* note 77, 108. Zenith had pioneered the system in an earlier analog format called 3XNTSC, which received its name from three times 525 or 1575 lines. HDTV, *supra* note 40, at 50.

[85]*Future of Electronics Companies*, *supra* note 5, at 60.

[86]M. Schubin, *Zenith scores points with bull-ish long distance HDTV broadcast*, 15 TELEVISION BROADCAST 3, 75 (June 1992). A recent delay was encountered when an EPROM was programmed wrong causing delays at the ATTC. A. Cole, *Zenith/AT&T HDTV Chips Fail*, 10 TV TECHNOLOGY 8 (June 1992).

[87]*Id.*

[88]L. Therrien, *HDTV Isn't Clearing up Zenith's Picture,* BUSINESS WEEK 54 (Feb. 25, 1991) [hereinafter *HDTV Isn't Clearing*].

[89]*Zenith-AT&T Advanced Television Development,* 44 PHYSICS TODAY 59 (1991).

[90] *HDTV Isn't Clearing, supra* note 88, at 56.

[91]*Id.* at 55.

[92]*Fifth Interim Report, supra* note 43, at 6 fn 6.

[93]HDTV, *supra* note 40, at 37-39.

[94]*Id.* at 40.

[95]*General Instrument bids for a coup,* 16 ELECTRONIC BUSINESS 39 (1990).

[96]B. Fox, *Digital TV transmissions squeeze into the home,* 128 NEW SCIENTIST 24 (Oct. 13, 1990) [hereinafter *Digital TV*].

[97]*Id.*

[98]*HDTV Homes, supra* note 77, at 108.

[99]R. Merrell, *DigiCipher looks at cellular HDTV,* 15 TELEVISION BROADCAST 3 (June 1992) [hereinafter *DigiCipher*].

[100]*See supra* text accompanying note 88.

[101] *DigiCipher, supra* note 99, at 75.

[102]*GI Hails Digicipher HDTV Lab Results,* BROADCASTING 31 (Sept. 14, 1992).

[103]*NBC, Sarnoff, supra* note 81, at 15.

[104]*High-Definition History,* 15 BYTE 300 (Dec. 1990) [hereinafter *High-Definition History*].

[105] Estimates vary from $700 million to as much as $1.3 billion. The *Big Picture, supra* note 3, at 30.

[106]B. Fox, *Japan's future TV lacks definition,* 132 NEW SCIENTIST 25 (Nov. 30, 1991).

[107]*High-definition television: Our next trick,* 320 THE ECONOMIST 68 (Sept. 7, 1991) [hereinafter *HDTV: Trick*].

[108]*Id.* at 300.

[109]These systems were MUSE, Narrow MUSE, MUSE-6, and MUSE-9. HDTV, *supra* note 40, at 12.

[110] *HDTV Sparks, supra* note 1, at 298.

[111] HDTV, *supra* note 40, at 71.

[112] *Easy Muse Returns,* BROADCASTING 39 (Sept. 28, 1992).

[113] A. Cole, *Zenith, GI To Divide HD Profits,* 10 TV TECHNOLOGY 1 (June 1992).

[114] H. Fields, *ATRC delay could be major set-back in race for HDTV standard,* 15 TELEVISION BROADCAST 6 (June 1992). *See also,* A. Cole, *MIT Takes Turn in Test Center,* 10 TV TECHNOLOGY 8 (Nov. 1992) [hereinafter *MIT Takes Turn*].

[115] *Armed Services, supra* note 30, at 23 (statement of Indraneel Paul, District Manager of Video Services Concepts of Bellcore).

[116] *MIT Takes Turn, supra* note 114, at 8.

[117] P. Lambert, *Zenith/AT&T Admit Flawed HDTV Lab Results,* BROADCASTING 25, 28 (Dec. 7, 1992).

[118] P. Lambert, *HDTV Field Tests: Pieces Fall Into Place for a 'Drive Around the Block,"* BROADCASTING 38 (Sept. 28, 1992).

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